

## Chapter 2

### Applications of Differentiation

#### Exercise Set 2.1

1.  $f(x) = x^2 + 4x + 5$

First, find the critical points.

$$f'(x) = 2x + 4$$

$f'(x)$  exists for all real numbers. We solve

$$f'(x) = 0$$

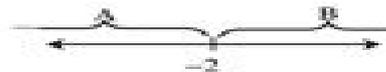
$$2x + 4 = 0$$

$$2x = -4$$

$$x = -2$$

The only critical value is  $-2$ . We use  $-2$  to divide the real number line into two intervals.

A:  $(-\infty, -2)$  and B:  $(-2, \infty)$ :



We use a test value in each interval to determine the sign of the derivative in each interval.

A: Test  $-3$ ,  $f'(-3) = 2(-3) + 4 = -2 < 0$

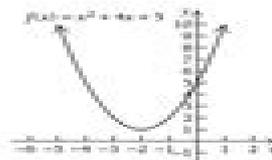
B: Test  $0$ ,  $f'(0) = 2(0) + 4 = 4 > 0$

We see that  $f(x)$  is decreasing on  $(-\infty, -2)$  and increasing on  $(-2, \infty)$ , and the change from decreasing to increasing indicates that a relative minimum occurs at  $x = -2$ . We substitute into the original equation to find  $f(-2)$ :

$$f(-2) = (-2)^2 + 4(-2) + 5 = 1$$

Thus, there is a relative minimum at  $(-2, 1)$ . We use the information obtained to sketch the graph. Other function values are listed below.

$x$	$f(x)$
$-5$	$10$
$-4$	$5$
$-3$	$2$
$-2$	$1$
$-1$	$2$
$0$	$5$
$1$	$10$



2.  $f(x) = x^2 + 6x - 3$

$$f'(x) = 2x + 6$$

$f'(x)$  exists for all real numbers. Solve

$$f'(x) = 0$$

$$2x + 6 = 0$$

$$2x = -6$$

$$x = -3$$

The only critical value is  $-3$ . We use  $-3$  to divide the real number line into two intervals.

A:  $(-\infty, -3)$  and B:  $(-3, \infty)$ .

A: Test  $-4$ ,  $f'(-4) = 2(-4) + 6 = -2 < 0$

B: Test  $0$ ,  $f'(0) = 2(0) + 6 = 6 > 0$

We see that  $f(x)$  is decreasing on  $(-\infty, -3)$  and increasing on  $(-3, \infty)$ , there is a relative minimum at  $x = -3$ .

$$f(-3) = (-3)^2 + 6(-3) - 3 = -12$$

Thus, there is a relative minimum at  $(-3, -12)$ .

We sketch the graph.

$x$	$f(x)$
$-6$	$-3$
$-5$	$-8$
$-4$	$-11$
$-3$	$-12$
$-2$	$-11$
$-1$	$-8$
$0$	$-3$



3.  $f(x) = 5 - x - x^2$

First, find the critical points.

$$f'(x) = -1 - 2x$$

$f'(x)$  exists for all real numbers. We solve

$$f'(x) = 0$$

$$-1 - 2x = 0$$

$$-2x = 1$$

$$x = -\frac{1}{2}$$

The solution is continued on the next page.

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**Jiyuan Zhang**



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